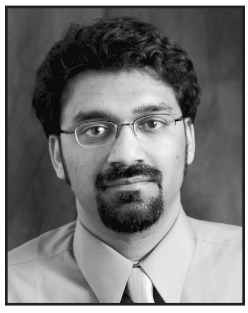
# Session 32 Overview

## TD: Trends in Wireless Systems



**Chair:** Donhee Ham, *Harvard University, Cambridge, MA*

**Associate Chair:** Siva Narendra, *Tyfone, Portland, OR*

Amid a plethora of wireless systems and applications that have become indispensable in our daily lives, there still continues to emerge burgeoning efforts to develop new wireless applications and systems.

Eight presentations comprising this session are designed to share some of these exciting applications and systems. Three papers discuss RF oscillators built with hybrid approaches that combine standard silicon integrated circuits with bulk acoustic wave resonators on the top or side of the IC, or with an optical system (modelocked laser). These hybrid approaches improve short- and long-term frequency stability beyond what silicon-only approaches can achieve. The other five papers are concerned with new integrated circuit or architecture designs in emerging wireless markets, including software defined radios, passive millimeter and submillimeter wave imaging, RF identification tags, and cognitive radios.

The authors of Paper 32.1, from IMEC and KU Leuven, report a Software Defined Radio that constantly estimates the required quality of service and opportunistically modulates its power usage to attain low energy operation. A Software Defined Radio approach combined with adaptive energy scaling enables both low-cost and low-energy.

In Paper 32.2, from Luxtera, OEwaves and Forza Silicon, the optoelectronic oscillator concept is realized by integrating, for the first time, the electronics in a CMOS integrated circuit, which leads to excellent phase noise performance. To attain the same goal of lowering phase noise, the authors of Papers 32.5 at U Washington and 32.7 at STMicroelectronics and IEMN/ISEN combine a bulk-acoustic-wave resonator with a standard silicon integrated circuit. The former also advances the state of the art by presenting the first such hybrid circuit with a quadrature topology.

Paper 32.3 from Northrop Grumman reviews passive millimeter wave and submillimeter wave imaging applications and reports amplifiers in the frequency range from 100GHz to 300GHz. These amplifiers are built with state-of-the-art InP high electron mobility transistors (HEMTs). The amplifiers may be used in the front end of the passive imaging cameras.

In Papers 32.4 and 32.8, UHF RFID tags are reported. In 32.4, from the Semiconductor Energy Laboratory and TDK, the RFID is implemented on a flexible substrate, with an effort to maximize the computation capability by including a central processing unit. The flexible substrate has the potential to enable ubiquitous application of such devices. The RFID tag reported in Paper 32.8 from TI conforms to the EPC Gen 2 standard and introduces an anti-collision architecture necessary for deployment of this technology.

Paper 32.6, from National Taiwan U, reports the first discrete wavelet multi-tone-based cognitive radio baseband receiver. This achieves 153.6 Mb/s data rate while consuming 165mW from a 1.8V supply.

**32.1 Architectures and Circuits for Software-Defined Radios: Scaling and Scalability for Low Cost and Low Energy** **1:30 PM**

*L. Van der Perre,* IMEC, Leuven, Belgium

Energy scalable architectures and circuits for SDRs are proposed, for both a reconfigurable RF front-end and a heterogeneous multi-processor SoC in a baseband platform. A performance/energy manager dynamically exploits the energy scalability and the dynamics in application requirements and propagation environment, realizing low-power operation. For the transmitter, the energy-scalability is translated to an average system-level energy-efficiency improvement of up to 40%.

**32.2 A Low-Phase-Noise 10GHz Optoelectronic RF Oscillator Implemented Using CMOS Photonics** **2:00 PM**

*C. Gunn,* Luxtera, Carlsbad, CA

A mostly integrated 10.2GHz optoelectronic oscillator (OEO) using Si photonics monolithic integration technology is reported. The OEO is a chip-scale device manufactured using a standard 0.13µm SOI CMOS process, with phase noise of -112dBc/Hz at 10kHz carrier offset and RF power consumption of less than 800mW.

**32.3 Advanced MMIC for Passive Millimeter and Submillimeter Wave Imaging** **2:30 PM**

*W. Deal,* Northrop Grumman, Redondo Beach, CA

Passive millimeter wave imaging systems above 100GHz have traditionally relied on mixer front-ends. InP HEMT low-noise amplifiers are reported for considerably higher frequencies, including a 70nm gate cascode amplifier with gain well into the 100GHz range, and two 35nm gate amplifiers operating at ~300GHz.

**32.4 UHF RFCPUs on Flexible and Glass Substrates for Secure RFID Systems** **3:15 PM**

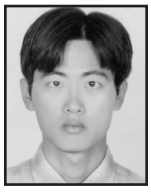
*Y. Kurokawa,* Semiconductor Energy Laboratory, Atsugi, Japan

A flexible RFID tag communicates using UHF RF signals at 915MHz, consists of an 8b CPU, and employs a DES and anti-side channel attack routine in firmware. The tag realizes stable clock generation by a digital control clock generator, and occupies an area of 10.5×8.9mm$^2$, is 145µm thick, consumes 0.54mW at 1.5V supply, and communicates with a maximum range of 43cm at a power of 9dBm.

**32.5 A 1V 600µW 2.1GHz Quadrature VCO Using BAW Resonators** **3:45 PM**

*S. Rai,* University of Washington, Seattle, WA

A 1V 600µW BAW-tuned quadrature VCO designed in 0.13µm CMOS is presented. The BAW QVCO operates at 2.1GHz and achieves a phase noise of -143.5dBc/Hz at 1MHz offset with a FOM of 212.1dB. The QVCO uses time-varying source degeneration to quadrature-couple the two VCO cores.



**32.6 A 1.8V 165mW Discrete Wavelet Multi-Tone Baseband Receiver for Cognitive Radio Applications** **4:15 PM**

*K-H. Chen,* National Taiwan University, Taipei, Taiwan

A 11.7mm$^2$ baseband receiver IC for a cognitive radio system, operating in the GSM band and using discrete wavelet multi-tone modulation is implemented in 0.18µm 1P6M CMOS technology. This chip provides up to 153.6Mb/s uncoded bit rate while consuming 165mW from a 1.8V supply.

**32.7 A 2GHz 0.25µm SiGe BiCMOS Oscillator with Flip-Chip Mounted BAW Resonator** **4:45 PM**

*S. Razafimandimby,* STMicroelectronics, Crolles Cedex, France, and IEMN/ISEN, Villeneuve d'Ascq/Lille, France

An RF oscillator consisting of a BAW resonator on top of a SiGe BiCMOS IC is presented. The circuit achieves a phase noise of -124dBc/Hz at 100kHz carrier offset, -160dBc/Hz floor and supply pushing of 65ppm/V while consuming 12mW in an IC footprint of 0.043mm$^2$.

**32.8 A Passive UHF RFID Transponder for EPC Gen 2 with -14dBm Sensitivity in 0.13µm CMOS** **5:00 PM**

*R. Barnett,* Texas Instruments, Dallas, TX

A passive RFID transponder conforming to the EPC Gen 2 standard is presented, including an RF and analog front-end, EEPROM, and a digital processing core and features a unique RF sampled analog random number generator to support the required anti-collision protocol. Fabricated in 0.13µm CMOS, the 0.55mm$^2$ IC functions at a sensitivity of -14dBm using an 860-to-960MHz carrier at 40-to-160kb/s RX data rates.